

CLAIMS

1. A strategic method for process control wherein said method includes the steps of: for a predetermined process juncture
 - 5 A. defining an interconnection cell having associated therewith
 - i. at least one set of input data or at least one set of process control parameters, and
 - ii. at least one set of output data;
 - 10 B. assigning at least one boundary value to at least one set of the sets associated with the defined interconnection cell;
 - C. using the assigned at least one boundary value, forming a plurality of discrete respective set combinations, and
 - 15 D. for the interconnection cell, processing data from the plurality of respective formed set combinations into respective corresponding data record clusters.
2. The method according to Claim 1 wherein defining an interconnection cell includes representing the interconnection cell as corresponding to a single stage in a process map.
- 20 3. The method according to Claim 1 wherein defining an interconnection cell includes representing the interconnection cell as corresponding to a group of contiguous stages in a process map.

4. The method according to Claim 1 wherein defining an interconnection cell includes representing the interconnection cell as corresponding to a group of discontinuous stages in a process map.
- 5 5. The method according to Claim 1 wherein defining an interconnection cell includes representing the interconnection cell as corresponding to a group of cells in a process map which includes therein substantially every stage in the process map.
- 10 6. The method according to Claim 1 wherein defining an interconnection cell includes representing the interconnection cell as corresponding to at least two interrelated interconnection cells in a process map.
- 15 7. The method according to Claim 1 wherein said at least one input data set includes historical empiric data obtained from a previously performed like-process.
- 20 8. The method according to Claim 1 wherein said at least one input data set includes data currently being obtained from a substantially presently ongoing like-process.
9. The method according to Claim 1 wherein defining the interconnection cell includes associating therewith derived data.

11. The method according to Claim 1 wherein defining the interconnection cell includes associating therewith values computed using at least one predetermined formula.

10 12. The method according to Claim 1 wherein defining the interconnection cell includes validating at least one set of the at least one set of input data to the interconnection cell as respectively having a substantially significant correlation with a set of the at least one set of output data.

15 13. The method according to Claim 12, wherein said validating includes calculating a correlation coefficient between a selected set of the at least one set of input data, and the at least one set of output data; for the interconnection cell.

20 14. The method according to Claim 1 wherein assigning at least one boundary value includes analyzing data in the respective set wherein the at least one boundary value is to be assigned.

15. The method according to Claim 14 wherein analyzing data in the respective set includes examining the data according to at least one predetermined criterion.

5 16. The method according to Claim 15 wherein examining the data according to at least one predetermined criterion includes electing a criterion selected from the list of:

10 A. Input constraints -

- i. within a specification limit,
- ii. within a range of values,
- iii. below an upper limit,
- iv. above a lower limit,
- v. closest to a mid-range value,
- 15 vi. closest to a previously used value;

B. Process constraints -

- i. closest recipe to most recent recipe,
- ii. within a specification limit,
- 20 iii. within a range of values,
- iv. below an upper limit,
- v. above a lower limit,
- vi. closest to a mid-range value; or

C. Output goals -

- i. within a specification limit,
- ii. within a range of values,
- iii. a predetermined target value,
- iv. an upper specification limit,
- v. a lower specification limit,
- vi. below an upper limit,
- vii. above a lower limit,
- viii. closest to a mid-range value.

17. The method according to Claim 1 wherein processing includes summarizing data in each respective corresponding data record cluster.

18. The method according to Claim 1 wherein processing includes implementing a Run-to-Run process control mode.

19. The method according to Claim 1 wherein processing includes running a feed back closed control loop.

20. The method according to Claim 1 wherein processing includes running a feed forward closed control loop.

21. The method according to Claim 20 wherein running a feed forward closed control loop includes substantial optimization of multiple outputs

22. The method according to Claim 1 wherein processing includes transforming each summarized respective corresponding data record cluster into a sub-manifold of a multi-variate data manifold.

23. The method according to Claim 1 wherein processing includes transforming each summarized respective corresponding data record cluster into a search-space vector.

24. The method according to Claim 23 wherein transforming each summarized respective corresponding data record cluster into a search-space vector includes arranging at least one search-space vector into a vector look-up table.

25. The method according to Claim 24 wherein the at least one search-space vector—having been arranged into a vector look-up table—is updated by using a self-correcting adaptive system.

26. The method according to Claim 1 wherein processing includes:

- A. for at least one process control parameter of the at least one set of process control parameters, prescribing at least one process control recipe-element for use in the predetermined process juncture; and

B. designating the prescribed at least one process control recipe-element for use in the predetermined process juncture.

27. The method according to Claim 1 wherein said processing includes using robust optimization.

28. The method according to Claim 1 wherein said processing includes characterizing data in substantially each respective corresponding data record cluster by using a statistical calculation.

29. The method according to Claim 28 wherein said using a statistical calculation includes calculating a process capability ratio.

30. The method according to Claim 28 wherein characterizing data in substantially each respective corresponding data record cluster by using a statistical calculation includes arranging the characterized data into a look-up table.

31. The method according to Claim 30 wherein arranging the characterized data into a look-up table includes using the look-up table and therewith designating at least one process control recipe for use at the predetermined process juncture.

33. The method according to Claims 30, 31, and 32 wherein arranging the smoothed characterized data into a look-up table includes using the look-up table for designating at least one process control recipe for use at the predetermined process juncture.

34. The method according to Claim 31 wherein using the look-up table for designating at least one process control recipe for use at the predetermined process juncture includes selecting a best available vector and therewith deriving a process control recipe.

35. The method according to Claim 33 wherein using the look-up table for designating at least one process control recipe for use at the predetermined process juncture includes updating said look-up table by using a self-correcting adaptive system.

36. The method according to Claim 34 wherein selecting a best available vector for use with the process control recipe includes running a feed forward closed control loop.

37. The method according to Claim 1 wherein processing includes—to the predetermined process juncture associated with the interconnection

cell—applying at least one of the respective corresponding data record clusters to the process occurring at that juncture.

38. The method according to Claim 37 wherein at least one of the respective corresponding data record clusters is updated by using a self-correcting adaptive system.

39. The method according to Claim 38 wherein applying at least one of the respective corresponding data record clusters includes reporting a process status, and wherein said reporting is initiated according to predetermined conditions.

40. The strategic method for process control according to claim 1 wherein the steps of the method are applied for optimizing a Chemical/Mechanical Polishing processing of silicon wafers.

41. A strategic method for process control wherein said method includes the steps of:

A. using a mapped plurality of graph-directed expertise-suggested interconnection cell relationships, defining a map referenced interconnection cell therein having associated therewith

- i. at least one set of input data or at least one set of process control parameters, and
- ii. at least one set of output data; and

B. using the map referenced interconnection cell, designating at least one process control recipe.

42. The method according to Claim 41 wherein defining includes, for the map referenced interconnection cell, validating at least one of the mapped plurality of graph-directed expertise-suggested interconnection cell relationships.

43. The method according to Claim 41 wherein defining the map referenced interconnection cell includes

validating the map referenced interconnection cell by

simulating a validity-metric for an n-tuple of directed graph components of the map referenced interconnection cell.

44. The method according to Claim 42 wherein defining the map referenced interconnection cell includes for an n-tuple of directed graph components of the mapped interconnection cell

validating the map referenced interconnection cell by

measuring if each of the at least one set of input data to the map referenced interconnection cell significantly contributes to that map referenced interconnection cell's output, wherein a predetermined convolution of these measurements constitutes an acceptable validity-metric.

45. The method according to Claim 41 wherein designating at least one process control recipe includes

choosing another process control recipe whenever a particular obtained output value differs from a predetermined target value, by at least a predetermined value,

thereby obtaining a new subsequent offset goal value closer to a predetermined target value.

46. The method according to Claim 45 wherein obtaining a new offset goal value includes basing the value upon at least one output value from a previous similar process.

47. The method according to Claim 46 wherein basing a new offset goal value includes analyzing the at least one output value from a previous similar process by running a feed back closed control loop.

48. The method according to Claim 41 wherein defining a map referenced interconnection cell includes forming at least two search-space vectors.

49. An article of manufacture including a computer usable medium having computer readable program code embodied therein for performing strategic process control at a predetermined process juncture, the computer readable program code in said article of manufacture including:

- A. first computer readable program code for causing a computer to define an interconnection cell having associated therewith
 - i. at least one set of input data or at least one set of process control parameters, and
 - ii. at least one set of output data;
 - B. tied to the first computer readable program code, second computer readable program code for causing a computer to assign at least one boundary value to at least one set of the sets associated with the defined interconnection cell; and
 - C. tied to the second computer readable program code, third computer readable program code for causing a computer to form a plurality of discrete respective set combinations, using the assigned at least one boundary value.
50. The article of manufacture according to claim 49 having computer readable program code embodied therein for causing a computer to arrange the respective corresponding data record clusters into a look-up table, for the interconnection cell.
51. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for performing strategic process control, said method steps including:
 - A. for a predetermined process juncture, defining an interconnection cell having associated therewith

- i. at least one set of input data or at least one set of process control parameters, and
 - ii. at least one set of output data;
 - B. for the predetermined process juncture, assigning at least one boundary value to at least one set of the sets associated with the defined interconnection cell;
 - C. for the predetermined process juncture, using the assigned at least one boundary value, forming a plurality of discrete respective set combinations, and
 - D. for the predetermined process juncture, for the interconnection cell, processing data from the plurality of respective formed set combinations into respective corresponding data record clusters.
- 52. The program storage device according to claim 51 including therein a method step whereby respective corresponding data record clusters are arranged into a look-up table.
- 53. A system for performing strategic process control at a predetermined process juncture including:
 - A. apparatus for delineating an interconnection cell, said interconnection cell having associated therewith
 - i. at least one set of input data or at least one set of process control parameters, and
 - ii. at least one set of output data;

B. a computer having therein software for assigning at least one boundary value to at least one set of the at least one set of input data or to at least one set of the at least one set of output data; and having attached thereto data storage apparatus for storing the assigned data sets;

C. a compressor for performing multi-dimensional representing, ordering, and combining of a plurality of discrete respective set combinations from the stored assigned data sets; and

D. a processor for processing data from the plurality of discrete respective set combinations into respective corresponding data record clusters.

54. The system according to Claim 53 wherein the processor includes attached thereto an applier for applying at least one of the respective corresponding data record clusters.

55. The system according to Claim 53 wherein the computer includes attached therewith at least one sensor for providing an input or output datum to the respective set of input or output data.

56. The system according to Claim 53 wherein the computer includes attached therewith at least one actuator for providing a process control parameter setting from the respective set of process control parameters, and the provided process control parameter setting is assigned according to a predetermined discrete respective set combination.

57. An article of manufacture including a computer usable medium having computer readable program code embodied therein for performing strategic process control at a predetermined process juncture, the computer readable program code in said article of manufacture including:

A. first computer readable program code for causing a computer to define a map referenced interconnection cell having therein a mapped plurality of graph-directed expertise-suggested interconnection cell relationships and further having associated therewith

- i. at least one set of input data or at least one set of process control parameters, and
- ii. at least one set of output data;

B. tied to the first computer readable program code, second computer readable program code for causing a computer to use the map referenced interconnection cell to designate at least one process control recipe.

58. A program storage device readable by machine, tangibly embodying a program of instructions executable by the machine to perform method steps for performing strategic process control, said method steps including:

A. for a predetermined process juncture, using a mapped plurality of graph-directed expertise-suggested interconnection cell

relationships, defining a map referenced interconnection cell therein having associated therewith

- i. at least one set of input data or at least one set of process control parameters, and
- ii. at least one set of output data; and

B. for the predetermined process juncture, using the map referenced interconnection cell, designating at least one process control recipe.

59. The method according to Claim 1 wherein processing data from the plurality of respective formed set combinations into respective corresponding data record clusters includes installing at least one data record cluster correspondence as a front end to a neural network, wherein the neural network is used for controlling an aspect of the process at the predetermined process juncture.

60. The article of manufacture according to claim 49 including a computer usable medium having computer readable program code embodied therein for performing strategic process control at a predetermined process juncture, the computer readable program code in said article of manufacture including: tied to the third computer readable program code, fourth computer readable program code for causing a computer to process data from the plurality of respective formed set combinations into respective corresponding data record clusters, for the interconnection cell.

- 5 61. The system according to Claim 53 wherein the processor includes attached therewith at least one actuator for providing a process control parameter setting from the respective set of process control parameters, and the provided process control parameter setting is assigned according to a predetermined discrete respective set combination.